Ecological Sustainability in Rapidly Urbanizing Watersheds: Evaluating Strategies Designed to Mitigate Impacts on Stream Ecosystems

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Collaborative Science and Technology Network for Sustainability
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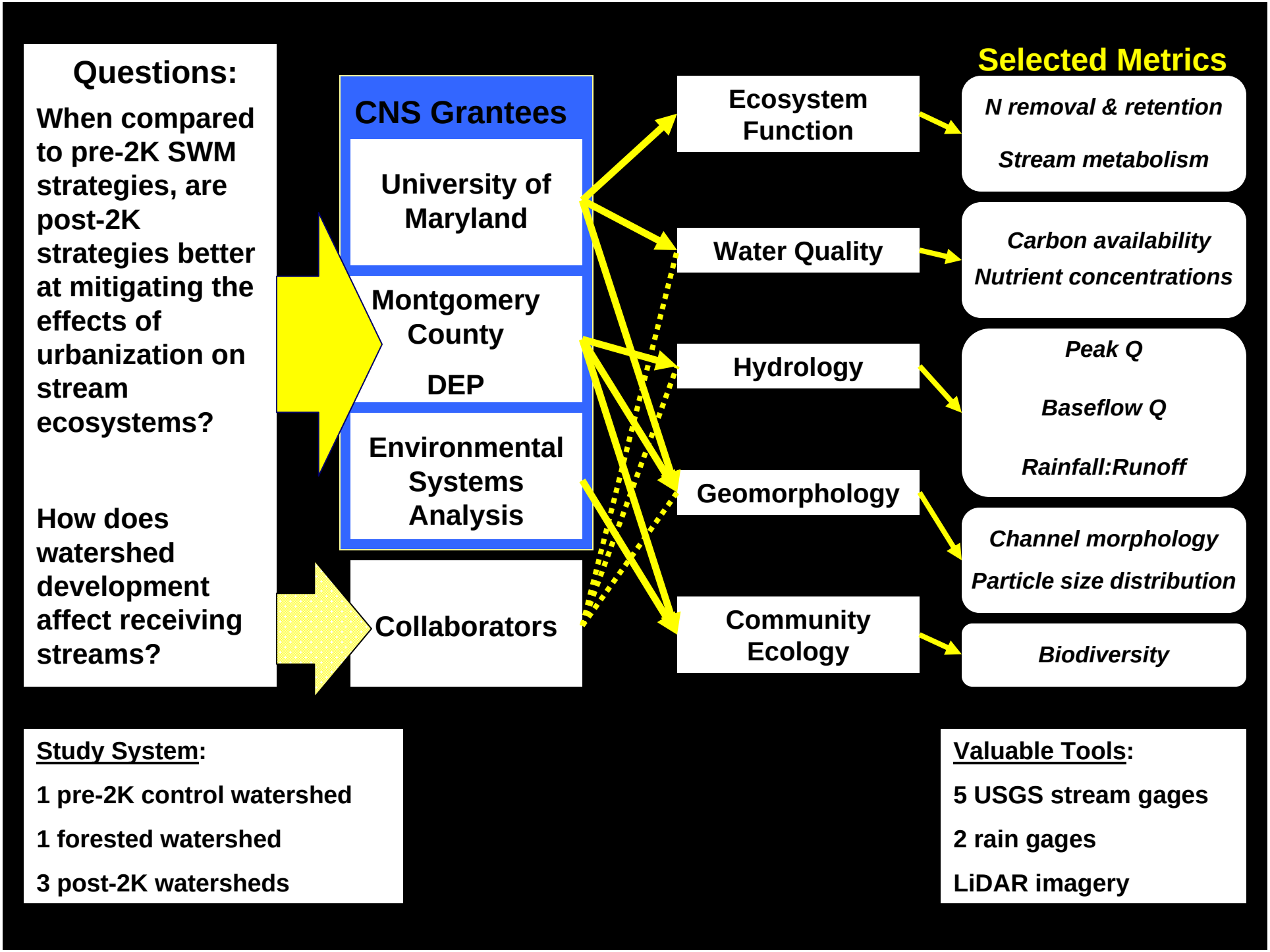
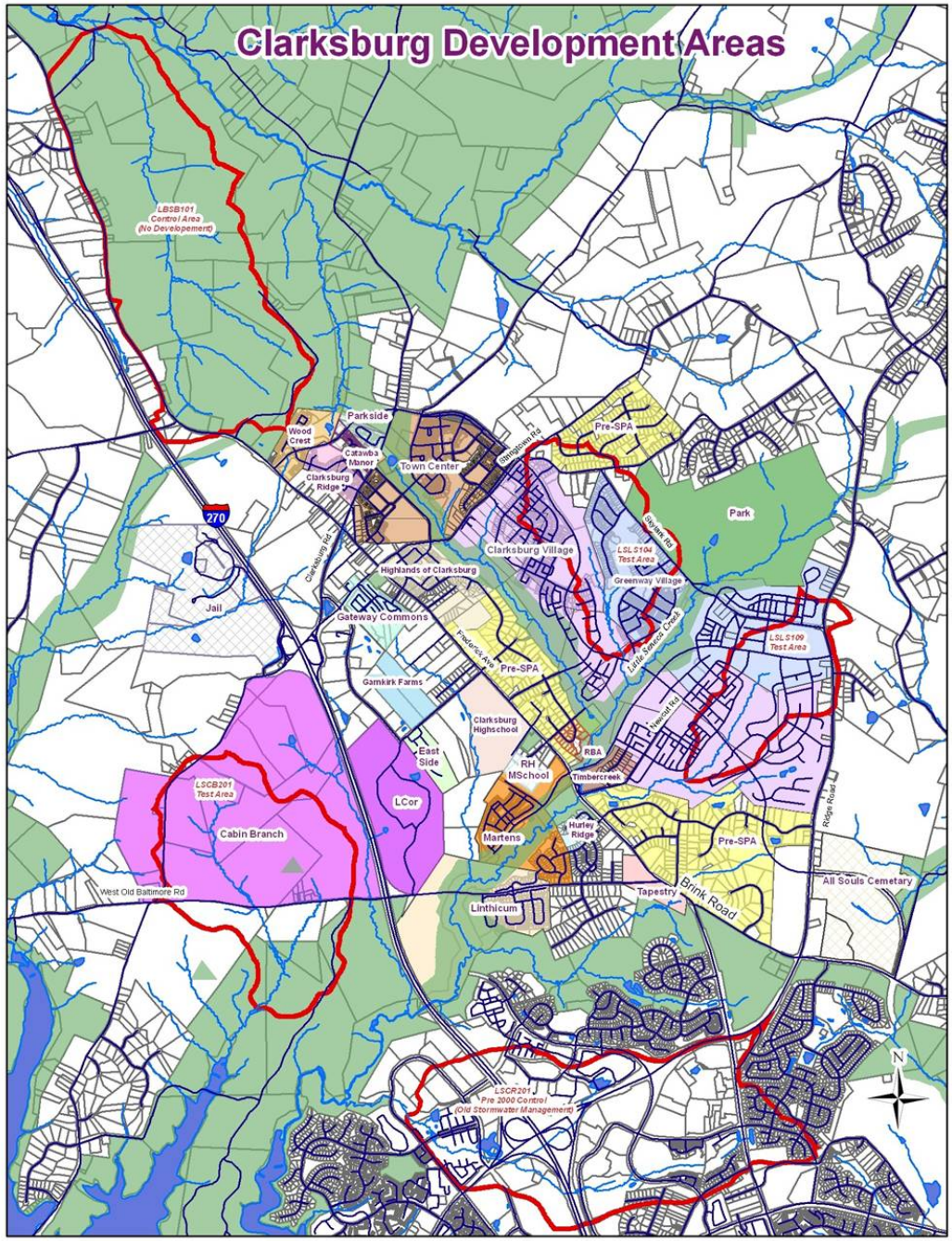
Environmental Systems Analysis


Questions:
When compared to pre-2K SWM strategies, are post-2K strategies better at mitigating the effects of urbanization on stream ecosystems?
How does watershed development affect receiving streams?
CNS Grantees
University of Maryland
Montgomery County DEP
Environmental Systems Analysis
Collaborators
Ecosystem Function
Water Quality
Hydrology
Geomorphology
Community Ecology
Selected Metrics
N removal & retention
Stream metabolism
Carbon availability
Nutrient concentrations
Peak Q
Baseflow Q
Rainfall:Runoff
Channel morphology
Particle size distribution
Biodiversity
Study System:
1 pre-2K control watershed
1 forested watershed
3 post-2K watersheds
Valuable Tools:
5 USGS stream gages
2 rain gages
LiDAR imagery

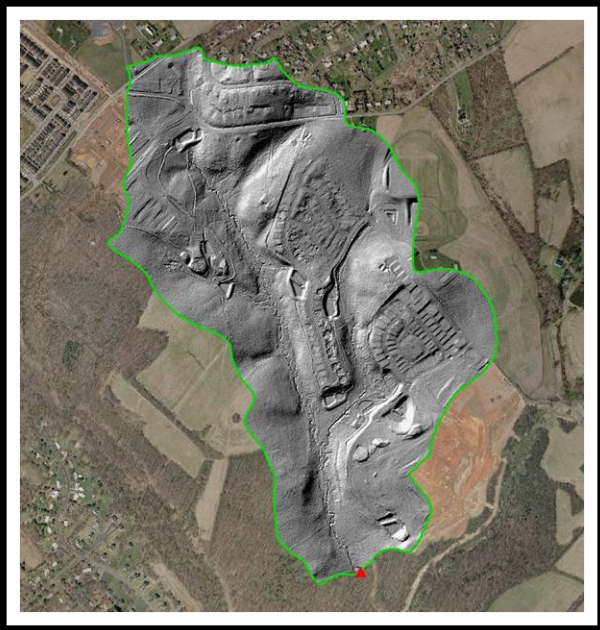


BACI Approach

2 Control drainages
3 Test areas

5 USGS stream gages
2 rain gages

LiDAR overflights



Meeting the needs of environmental decision-making for sustainability

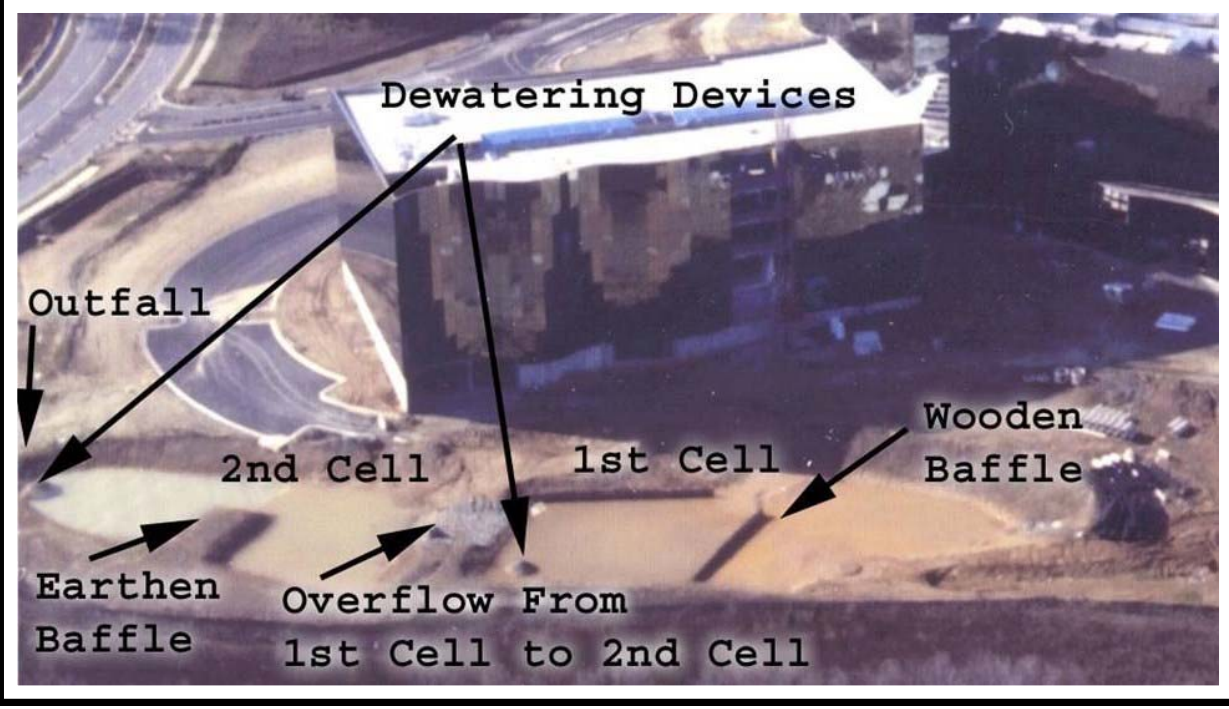
- Documenting ecosystem response/recovery to long term and significant landscape changes
- Documenting effectiveness of sediment and erosion control and SWM best management practices
- Providing feedback to decision-makers regarding development and SWM design
- Devising more focused research questions based on the needs of managers and decision-makers

“Lessons Learned”

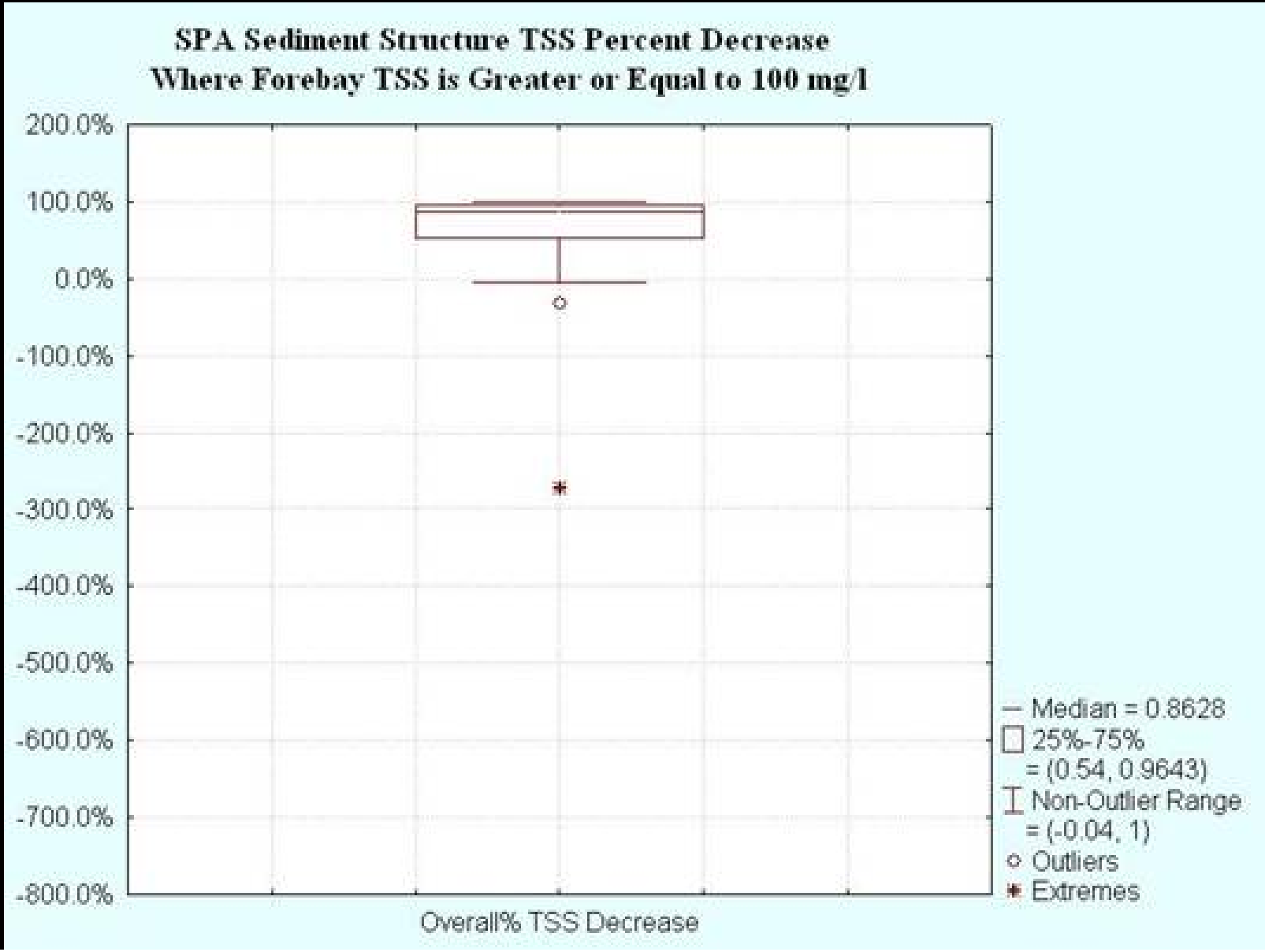
Questions and methods must be adaptable when studying large-scale treatments that you cannot control

- Conversion of sediment control to SWM has been slower than expected
  - Building moratorium imposed on study area
  - Conversion can only occur when 100% of drainage area is controlled
- Speed of development has slowed over the course of the study
  - Slow down of housing market
- “Treatment” effects may be masked by larger local effects
  - Cut and fill
  - Loss of natural drainage patterns
  - Influence of local geology and physiography

The Long Construction Phase



Sediment and erosion control devices are, at best, 86% efficient



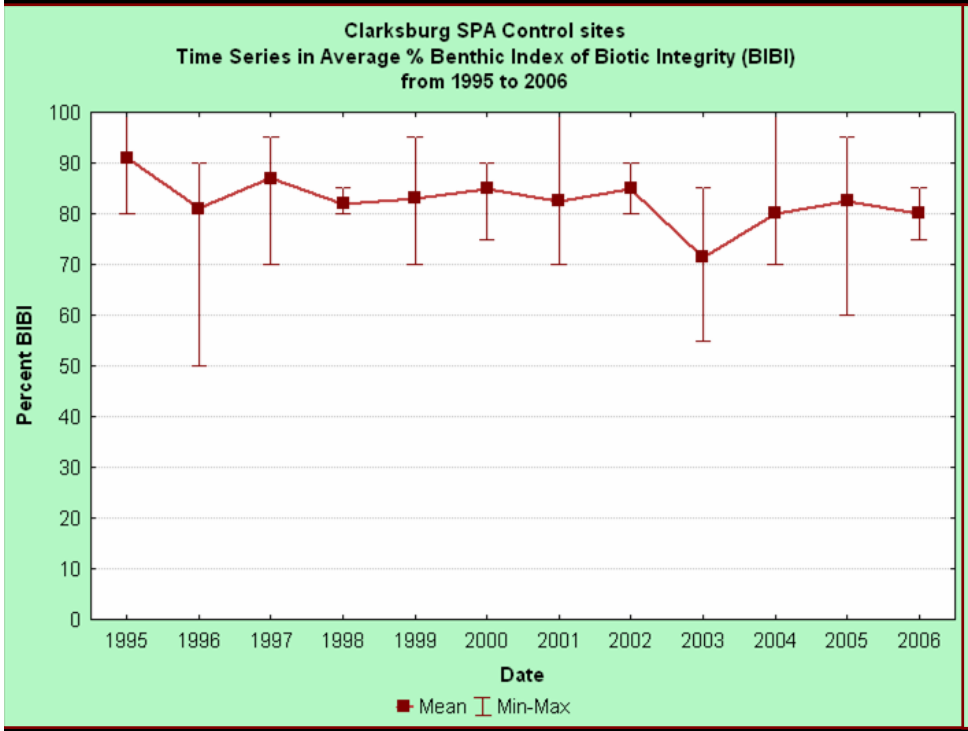
Development results in changes to in-stream habitat

2002

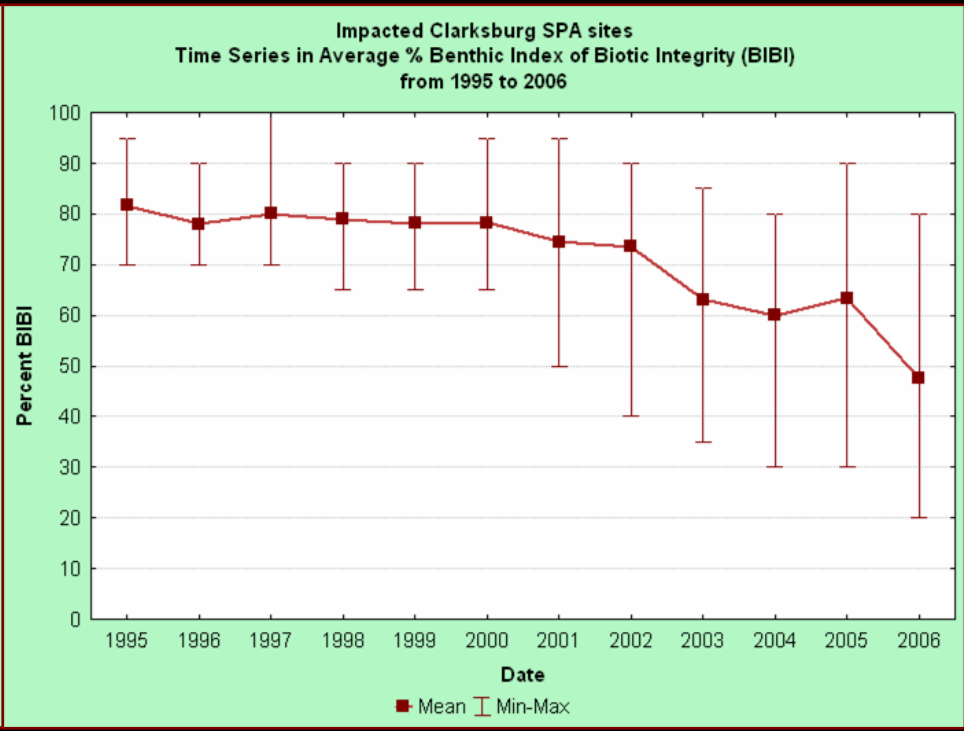
2005

Construction phase profoundly changes benthic macroinvertebrate community composition

Benthic Macroinvertebrate IBI Scores



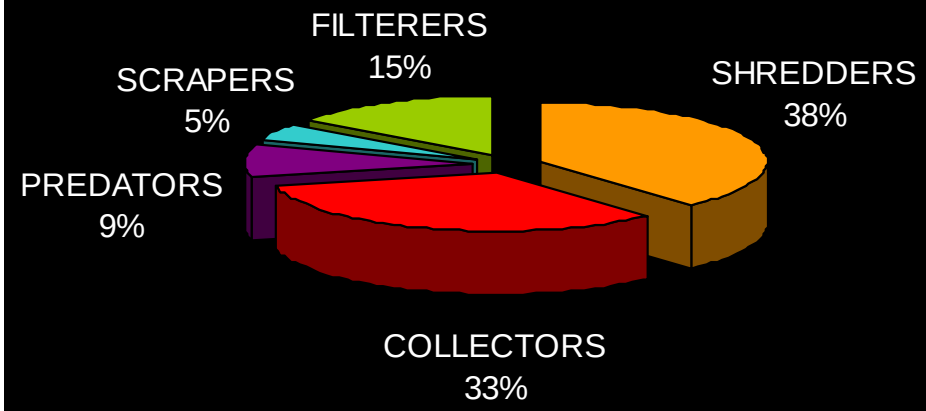
Control Sites



Impacted Sites

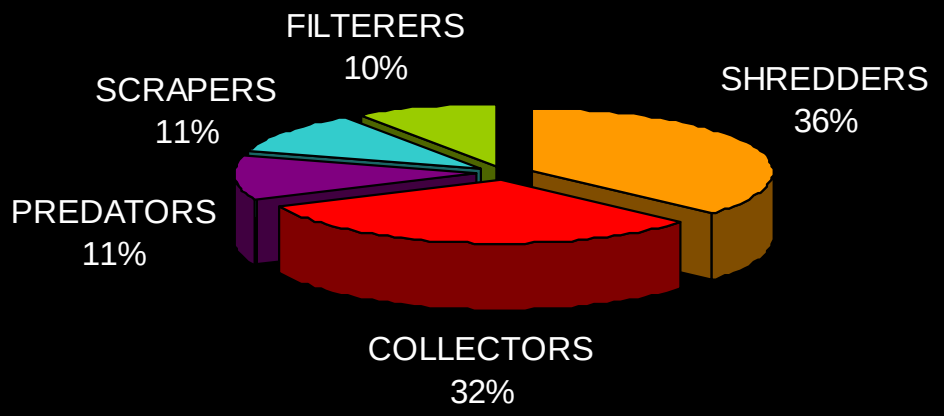
Changes in Benthic Macroinvertebrate Community Composition (Control Sites)

1996-2000



Dominant Taxa:
Amphinemura= 33% Shredder
Chironomidae= 21% Collector
N= 24, Total # of Stations = 7

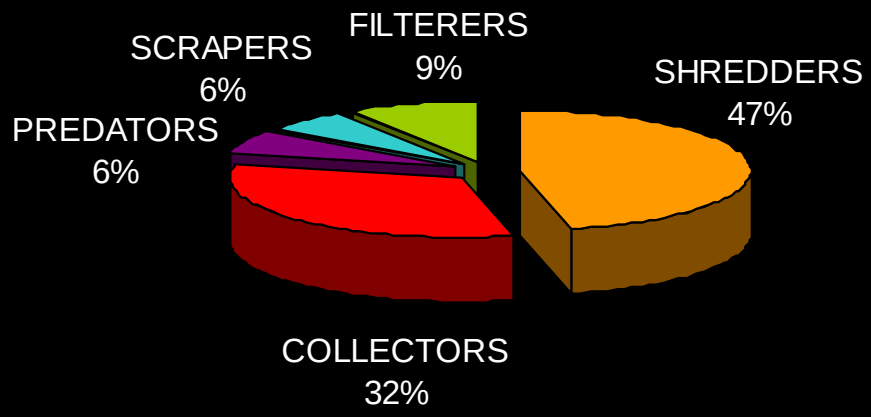
2003-2006



Dominant Taxa:
Amphinemura = 34% Shredder
Orthocladiinae= 13% Collector
N = 17, Total # of Stations = 7

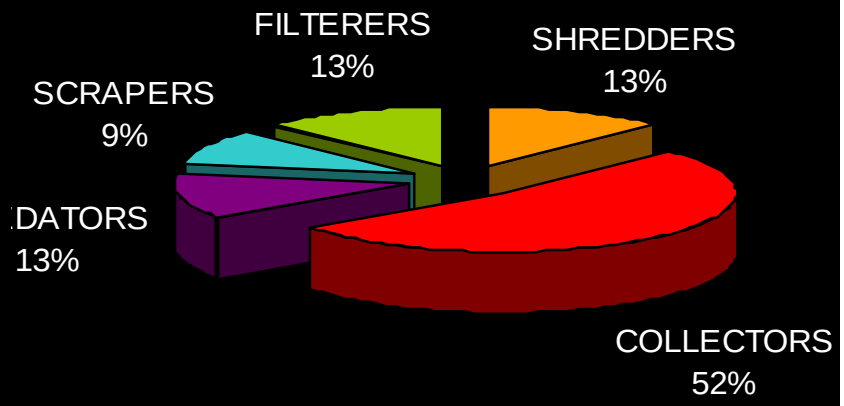
Changes in Benthic Macroinvertebrate Community Composition (Impacted Sites)

1996-2000



Dominant Taxa:
Amphinemura= 43% Shredder
Chironomidae= 20% Collector
N= 35, Total # of Stations = 9

2003-2006



Dominant Taxa
Orthocladiinae = 24% Collector
Chironimini= 13% Collector
N = 31, Total # of Stations = 9

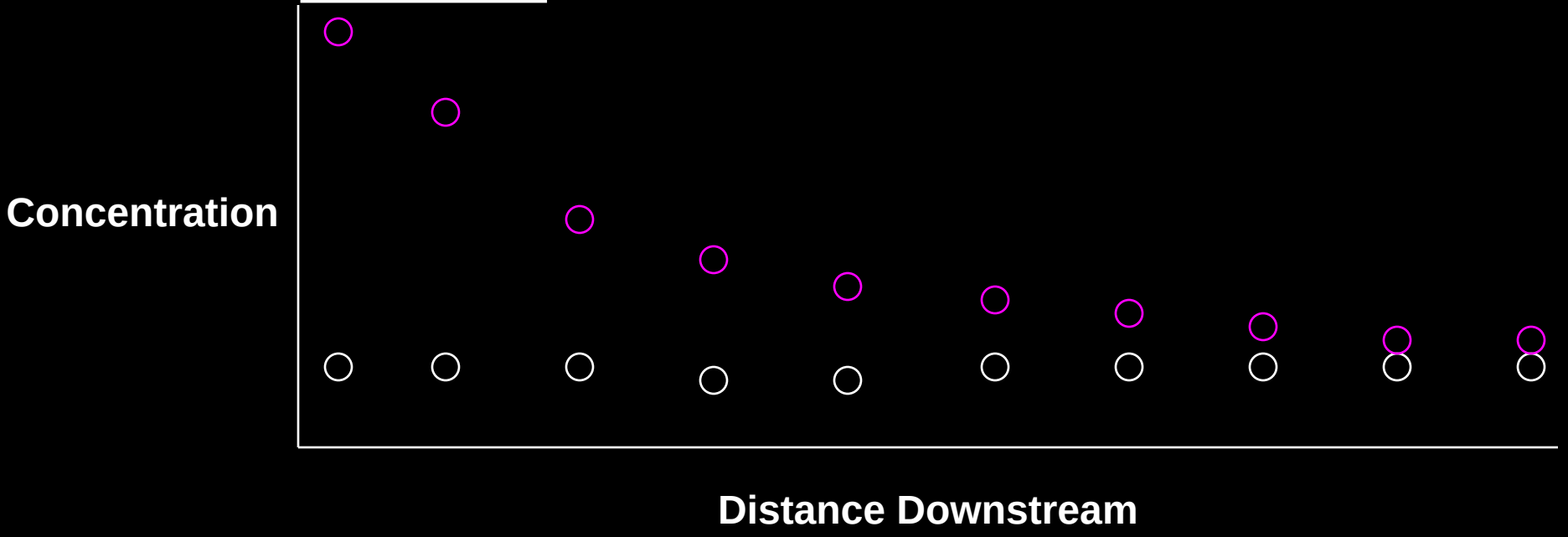
In-stream NO_3^- uptake cannot be detected in Clarksburg study watersheds

Measured NO_3^- uptake at each site:

Summer and Fall 2005

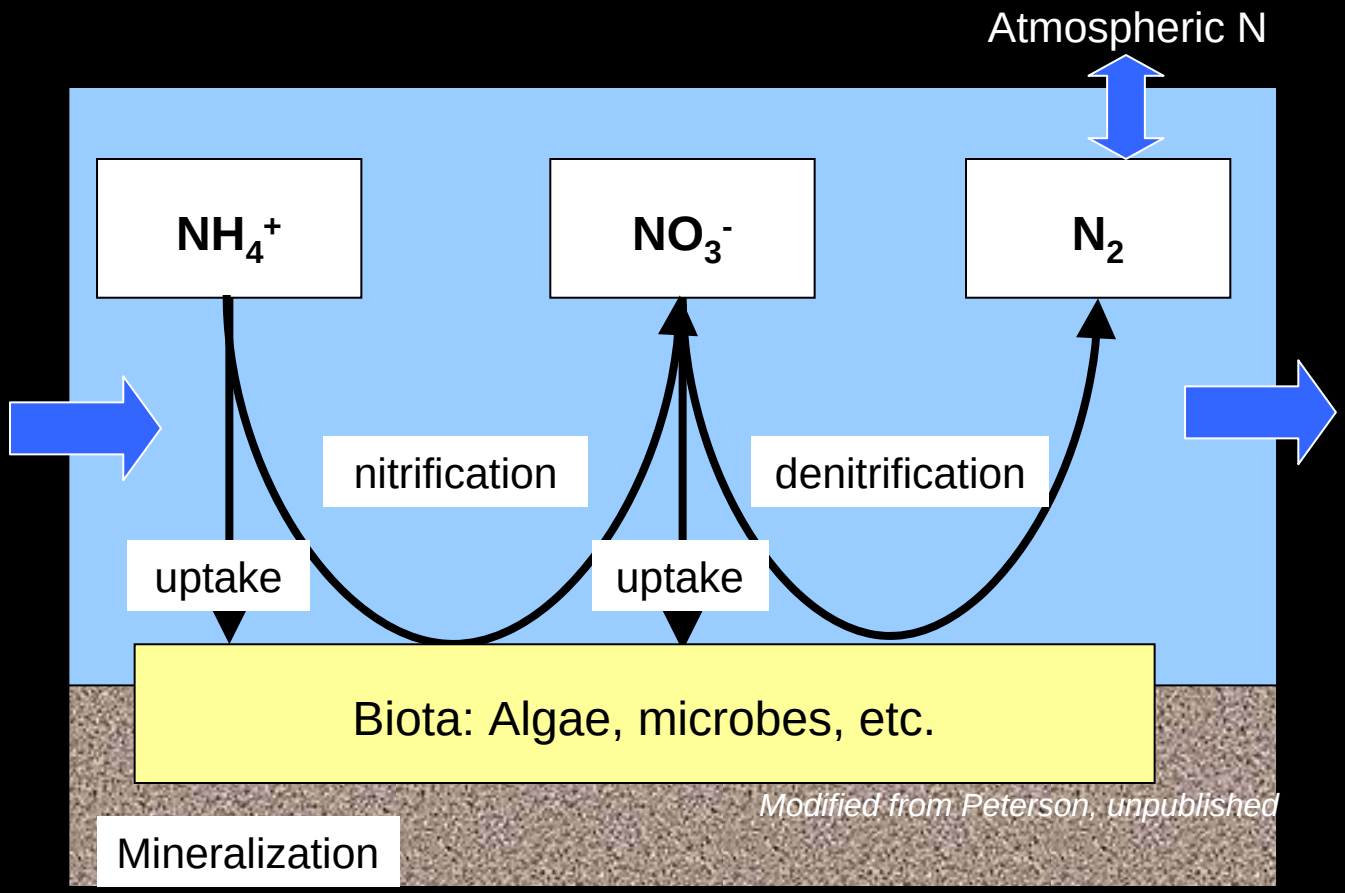
Spring, Summer, and Fall 2006

Summer 2007



Nutrient concentrations do not change with distance downstream!

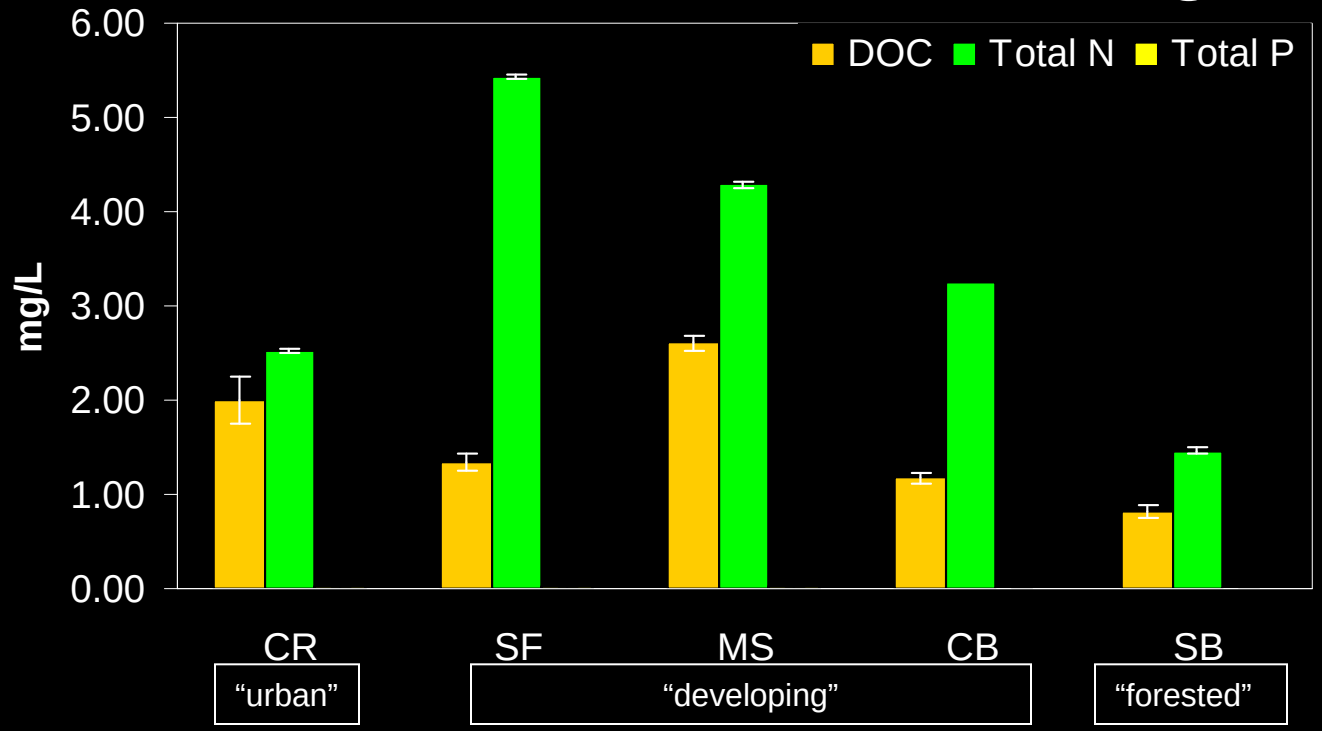
Why can't we measure NO_3^- uptake in Clarksburg??

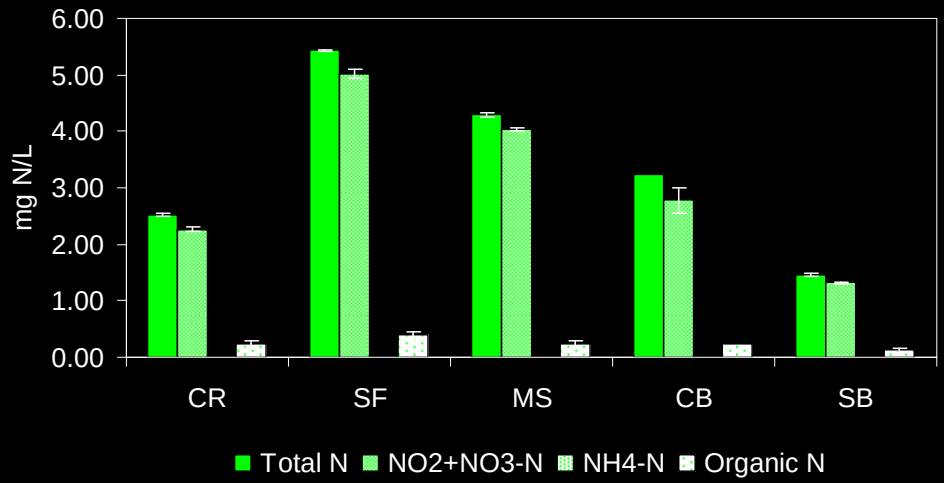


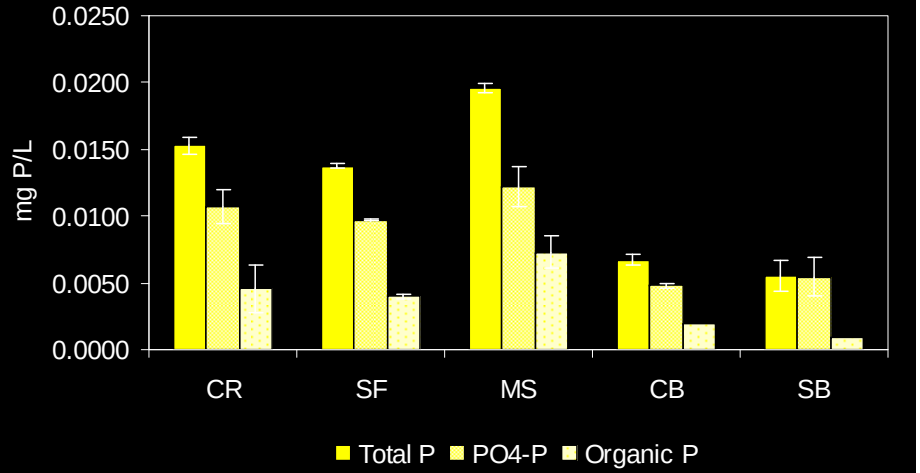
Streams are N saturated / Other nutrients are limiting

Nitrification is producing NO_3^- (masking effects of removal)

Are streams N saturated?
Are other nutrients limiting?

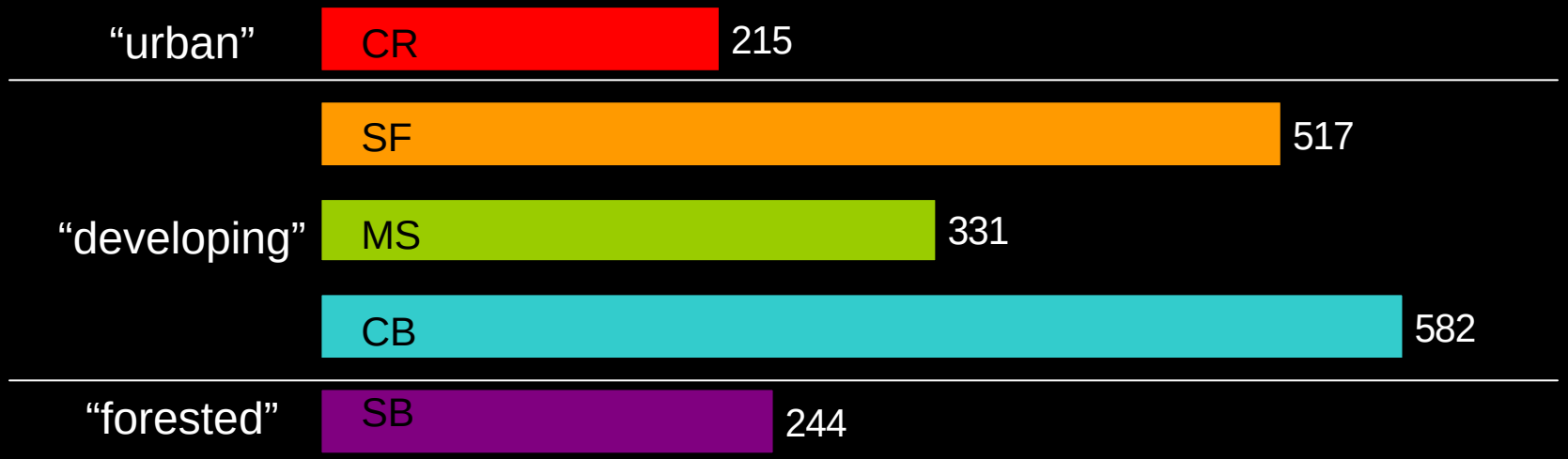






Are streams N saturated?
Are other nutrients limiting?

DIN:SRP is a strong predictor of N saturation (Earl *et al.* 2006)



Study streams appear N saturated

C and P may be limiting uptake by benthos

Local conditions “mask” treatment effects!

Ways the CNS Funding & Program have Helped Us

- Creation/recognition of the Clarksburg Integrated Ecological Study Partnership has increased the number contacts from potential collaborators
- Helped leverage funding and in-kind services
- Provided a level of “legitimacy” to the county’s efforts to understand effects of land use change to receiving streams and biota
- Networking has provided increased access to information, people, and equipment
- Research funded by CNS has led to new and interesting research questions regarding the effects of land use on stream ecosystems.

Update on Collaborators and Partners

S. Taylor Jarnagin, EPA-EPIC

Mapping landscape change and channel morphology using LiDAR

Dianna Hogan, USGS-Reston

Direct measurement of SWM BMP effectiveness

John W. Jones, USGS-Reston

Land use change and climate

Yusuf M. Mohamoud, EPA-NERL

Modeling urban development with HSPF

Kaye Brubaker, Vince Gardina, University of Maryland

Accuracy of LiDAR in different canopy densities

Gary Fisher, WRD, USGS

Collaborator on 5 USGS stream gages

M-NCPPC Park Managers and Ecologists

Response to feedback from partners, CNS grantees, and others

Expanded partnerships with collaborators and the generation of additional data related to our original questions.

- Multi-year LiDAR coverage captures landscape and stream changes (Jarnagin)
- Accuracy assessment of LiDAR (Jarnagin)
- Creation of ARCMAP coverages (Hogan)
- Creation of BMP database (Hogan)

Discussions with other grantees at last year's meeting provided insight regarding data and inspired follow-up experiments

Motivated the upgrade of the USGS gauge at our urban site to "real-time" allowing for public access

The Future of “Ecological Sustainability in Rapidly Urbanizing Watersheds”

Continued monitoring to gain a long-term understanding of the effects of land use change and SWM on geomorphological and ecological metrics as funding allows

Continued collaborative efforts

Pursue interesting “spin-off” questions

Publication of results (DEP releases and peer-reviewed journals)

Questions?

Comments?

Feedback?